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CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

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COUNTRY USSR

SUBJECT Comments and Reviews of 14 Articles on Steel, Metallic Alloys, Powder Metallurgy Metal Treatment and Propaganda.

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DATE DISTR. 22 Sep. 1954

NO. OF PAGES 14

NO. OF ENCLS.

SUPP. TO REPORT NO.

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THIS IS UNEVALUATED INFORMATION

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I N D E X (Continued)

1. X-Ray Analysis of Steels Diffusion-Coated with Beryllium or Boron by G F Kosolapov and N G Sevast'yanov, Zhurnal Tekhnicheskoy Fiziki 11 (1941) no. 7, pp 607/612

A. Research. Investigation of samples prepared by I Ye Kantorovich showed the presence - in addition to the saturated solid solution of iron - of the following compounds:

	0.4% C - 0.95% Cr steel	0.2% C - 12.0% Ni steel
diffusion treatment		
beryllium	1000 C (10 hr)	1000 C (20 hr)
boron	1000 C (20 hr)	1000 C (20 hr)
compounds		
beryllium	$FeBe_5$, $FeBe_2$	$FeBe_5$, $FeBe_2$, NiBe
boron	Fe_4B_2	Fe_4B_2, Ni_2B

Unlike nitrided steels, where the hard case consists mainly of a solid solution of nitrogen in steel with a small amount of nitrides, the high hardness of the outer layers of steels diffusion-coated with beryllium or boron stems from the presence of large amounts of chemical compounds, which seem to be the major components of the case.

B. The results obtained appear reasonable in view of pertinent phase diagrams, although Fe_4B_2 is generally given today as Fe_2B. Kosolapov and Sevast'yanov mention specifically that no ternary compounds were present; this would presumably mean that small amounts of carbon (and chromium in the case of the low-alloy steel) were dissolved in the beryllides and borides.

C C McBride, J W Spretnak and R Speiser: A Study of the Fe-Fe_2B System. TASM 46 (1954) pp 499/520; disc 520/524

R M Parke: B-Fe Boron-Iron. Metals Handbook (1948) p 1175

E N Skinner: Be-Ni Beryllium-Nickel. Metals Handbook (1948) p 1177

R J Teitel and M Cohen: The Beryllium-iron System. TAIME 185 (1949) pp 285/296

C. No further information is given on the samples. The high hardness of the beryllium-diffused steel is documented only by a reference to Laissus (reference 1). Since Kosolapov and Sevast'yanov were working in the Aviation Materials Division of the All-Soviet Institute, Kantorovich (or someone else) may have thought that these materials would have certain applications in aircraft. Minkevich, however, has indicated that neither beryllium nor boron coatings had gained any industrial use in the ten years between the present paper and the publication of his book.

A N Minkevich: Chemico-Thermal Treatment of Steel. Moscow (1950) 432 pp

D. Kosolapov and Sevast'yanov indicate a rather naive surprise at the fact that nitrided steels were so widely used in industry such a short time after the granting of patents on nitriding. Since nitriding was first introduced and patented in the '20's, it is not at all astonishing to anyone in the USA that nitrided steels were industrially prominent in 1941.

E. All six references are non-Soviet.

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2. Effect of Temperature on the Stability of an Undercooled Phase by N N Sirota. Doklady Akademii Nauk SSSR 74 (1950) no. 5, pp 971/974

A. Mathematical treatment of isothermal transformation.

1) A comparison of calculated and experimental data on the isothermal formation of pearlite in a carbon steel with 0.97% C showed that the equations correctly described the reaction, including the size and orientation relations between the initial phase and the phase formed.

2) There was qualitative agreement between calculated and experimental data on the changes in the rate of transformation.

3) The eutectoid reaction, where alpha iron is the initial phase, has a higher linear rate of growth than that of either of the two phases individually.

B. No single mathematical treatment of the eutectoid reaction has yet been universally accepted. Sirota's work, however, has certain evident inaccuracies. For instance, it is generally believed here that cementite rather than ferrite (alpha iron) nucleates pearlite. Sirota also fails to consider some of the factors considered pertinent by most USA investigators.

J C Fisher: Eutectoid Decompositions. Thermodynamics in Physical Metallurgy. ASM (1950) pp 201/241

C Zener: Kinetics of the Decomposition of Austenite. TAIME 167 (1946) pp 550/583; disc 583/595

C. A carbon content of 0.97% seems too high to be considered "eutectoid". In pure iron-carbon alloys, the eutectoid composition contains about 0.80% C.

D. Six references, all Soviet.

3. On a Single Mechanism of Fracture and a Single (Normal) Strength of Metals. by E M Shevandin. Zhurnal Tekhnicheskoy Fiziki 18 (1948) no. 6, pp 863/874

A. A critical consideration, based on part on his own work, of the two conflicting theories of fracture: the Davidenkov-Fridman brittle-ductile strength; and the Kuntze-Orowan normal-stress theory. It is concluded that the latter is correct even though it is difficult to devise experimental proof. In other words, rupture begins in all cases with distortion created by plastic deformation (twinning or shear), then fracture occurs under the influence of the normal stress.

B. A good paper in a field in which much work has been done in the USSR and USA. USA views on fracture roughly contemporary with this paper by Shevandin are given below. As yet, none of the theories of fracture is able to explain everything. Therefore there is considerable disagreement among the various writers in the USA as well as elsewhere.

J H Hollomon: The Problem of Fracture. Welding Research Council 11 (1946) pp 534-s/563-s

M Gensamer, E Saibel and J T Ransom: Report on the Fracture of Metals. Welding Research Council 12 (1947) pp 443-s/484-s
Fracturing of Metals. ASM (1948)

C. Shevandin refers to a 1940 paper by Orowan (reference 7). Orowan's theory has been somewhat modified and expanded since this time. Also there were publications by Orowan between 1940 and 1948 that are not included in Shevandin's bibliography.

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D. It is noticeable that dislocations are not considered a factor in fracture by Shevandin although they are generally so considered here in recent years.

E. While much of the experimental work on fracture has dealt only with relatively soft, low-carbon steels, Shevandin refers to tests he has made on high-strength quenched-and-tempered steels. No details are given, so it is impossible to judge just what strengths were involved and what the possible applications might have been.

F. Of 14 references, ten Soviet.

4. On the Two Types of S-Shaped Curves Showing Stability of Undercooled Phases by N N Sirota. Doklady Akademii Nauk SSSR 74 (1950) no. 6, pp 1105/1108

A. Theoretical. The two types of S curves are "normal" and "complex". The latter type results when variations in the degree of undercooling cause a change in the composition - or in a number of cases, the structure - of the precipitated phase. Complex curves are therefore related to the appearance of metastable compounds, which differ from stable compounds in composition and sometimes also in structure.

S curves of chromium steels (1% C, 3% Cr), for instance, are complex because different carbides are formed in different temperature ranges of isothermal decomposition. S curves of unalloyed steels with 1% C may also be considered complex if a wide range of decomposition temperatures is considered; as, with very slight degrees of undercooling, primary graphite is formed; on undercooling down to 300 C, primarily cementite; on undercooling to temperatures below 300 C, primarily Fe_xC.

B. A fuzzy bit of theorizing.

1) This seems to be a case of "all generals" and "no privates". In other words, apparently all S curves for steels and alloys would come within the category of "complex" as defined by Sirota. No examples of "normal" curves are given, nor would any actual curves for steels and alloys meet the qualifications.

2) Sirota does not make clear precisely what meaning is to be attached to "stable". Does this apply - in the case of steels - to carbides that are stable on long-time holding at the temperature of formation, or perhaps only to carbides that would be stable under equilibrium conditions?

3) No example of the formation of graphite directly from austenite in a eutectoid steel is known. High carbon steels with moderately high silicon contents, however, may form carbides that graphitize rapidly on continued holding at high decomposition temperatures.

C. All seven references are Russian, and four of these refer to previous papers by Sirota.

5. Structure of Aluminum-Zinc Alloys and Structural Analogies in Other Alloys by D A Petrov and T A Badaeva. Zhurnal Fizicheskoy Khimii 21 (1947) no. 7, pp 785/797

A. Research. Although the aluminum-zinc phase diagram has been investigated for over 50 years, two questions remain: 1. the explanation of the "peritectic ring"; and 2. the unusual form of the solidus from 60 to 72% Zn. Alloys with 20 to 96% Zn were examined for changes in microstructure, differential heating and cooling curves, changes in electrical resistivity at high temperatures, and changes in the lattice parameter at high temperatures.

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1) The formation of independent intermediate phases that has been assumed until now does not occur.

2) Anomalies at 443 C are explained by the formation of an ordered structure in the solid-solution field with more than 60% Zn. Unlike other superstructures known previously, the ordered solid solution remains stable up to the melting point. Similar superstructures have also been observed in other systems, such as iron-silicon, gold-manganese, thallium-bismuth.

3) Thus a new type of phase is established. There is a continuous change from unordered solid solution to ordered solid solution with a different composition. In these systems, the ordered structure is retained up to the melting point, which is directly reflected in the phase diagram. The well-known superstructures, such as Cu_3Al, Fe_3Al, are different as they are not stable at high temperatures and change into unordered solid solutions.

B. This type of ordering is not generally accepted for any of these systems. Bochvar, Sviderskaya and Korbut at about the same time believed they had proved the presence of a peritectic at 443 C in the aluminum-zinc system. On the other hand, Hume-Rothery and the Metals Handbook showed neither a peritectic nor ordering. The latter reference considers that heat effects at 443 C have not been explained convincingly.

A A Bochvar, Z A Sviderskaya and E K Korbut: On the Question of the Expansion of Some Alloys on Solidification. Izvestiya Akademii Nauk SSSR Otdeleniye Tekhnicheskikh Nauk (1947) no. 4, pp 409/417

E A Anderson: Al-Zn Aluminum-Zinc. Metals Handbook (1948) p 1167

W Hume-Rothery: Atomic Theory for Students of Metallurgy. The Institute of Metals (1947)

C. Petrov and Badaeva apparently were unaware of the earlier work by Isaichev and Iretsky, who found that the NiAl phase formed in an ordered condition from the liquid solution. Therefore, Petrov and Badaeva's "new" type of phase really was not so new after all.

A H Geisler: Discussion of F N Rhines and J B Newkirk: The Order-Disorder Transformation Viewed as a Classical Phase Change. TASM 45 (1953) pp 1029/1046; disc 1046/1055

I Isaichev and V N Iretsky: X-Ray Study of the Beta-Phase in the System Ni-Al at High Temperatures. Zhurnal Teknicheskoy Fiziki 10 (1940) p 316

D. Only four of the 18 references are Soviet.

6. Relation between the Type of Constitution Diagram of Binary Alloys and Molecular Interaction by D S Kamenetskaya. Zhurnal Fizicheskoy Khimii 22 (1948) no. 1, pp 81/89

A. Mathematical. A geometric method of analysis is proposed for thermodynamic potentials calculated by the Becker-Pinex method. The different types of constitution diagrams according to Roozeboom are considered as related to the molecular interaction. The type of constitution diagram is determined by the sign and relative value of the energy of mixing of the two phases, and also - in some cases - by the relative magnitude of the melting temperature of the pure components.

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B. Not an unusual method of approach. The same limitations seem to apply as those mentioned by Lawson for his method:

"Probably the most serious limitation on the use of the equation of state derived above is the fact that the entropy of mixing is found to be ideal, and the whole blame for lack of regularity is thrown on the heat of mixing, i.e., on energy terms. While this type of approximation is widely used in physical chemistry, it is known to be seriously in error in certain systems. The reasons for this are not clearly understood at the present time and present an inviting and fertile field for further investigation."

A W Lawson: <u>On Equations of State and the Phase Diagrams of Simple Binary Alloys.</u> Thermodynamics in Physical Metallurgy. ASM (1950) pp 85/101

7. <u>Ternary Aluminum-Magnesium-Lithium System. Part I.</u> by F I Shamray. Method of Working with Lithium. Binary Systems, Izvestiya Akademii Nauk SSSR Otdeleniye Khimicheskikh Nauk (1947) no. 6, pp 605/616

<u>Ternary Aluminum-Magnesium-Lithium System. Part II.</u> by F I Shamray. Phase Diagrams of Auxiliary Section. Izvestiya Akademii Nauk SSSR Otdeleniye Khimicheskikh Nauk (1948) no. 1, pp 83/94

<u>Ternary Aluminum-Magnesium-Lithium System. Part III.</u> by F I Shamray. Description of Ternary Al-Mg-Li System. Projection of Liquidus Surface. Isotherms at 400 C and 20 C and Process of Crystallization. Izvestiya Akademii Nauk SSSR Otdeleniye Khimicheskikh Nauk (1948) no. 3, pp 290/301

A. Research

1) After a discussion of previous work, new binary diagrams were established for magnesium-lithium (figure 8) and aluminum-lithium (figure 10). Experiments showed that of all the previous aluminum-magnesium diagrams, the Kurnakov-Mikheyeva version was substantially correct except for a few slight changes.

2) The auxiliary sections presented in Part II are those parallel to the aluminum-magnesium side with 5, 10, 15, 20, 30, 50 and 60 atomic % Li, and those passing through Al_3Mg_4 - AlLi and through Al - Mg_2Li. These were based on the results of various tests including thermal analysis, microstructure, hardness and electrical conductivity; but only the final sections and microstructures are given.

3) In Part III attention is directed to various ternary fields that may have practical importance, and particularly to the wide range of solid solutions based on aluminum and magnesium. Lithium seems prone to form numerous high-melting-point phases of variable composition, both with pure metals and with binary [illegible] compounds [illegible]

B. There is no indication in these three papers that any more practical investigations of these alloys had been made. Nor does Shamray point out the basic advantages to be gained by the addition of lithium to magnesium alloys. While Shamray was carrying out his fundamental research on the complete ternary phase diagram, more practical studies were being made in the USA and Great Britain.

In the USA, Battelle Memorial Institute (sponsored by Mathieson Chemical Corp) and Dow Chemical Co carried out considerable work during World War II on the production and properties of magnesium-lithium alloys. At about the same time, somewhat similar investigations of magnesium-lithium and magnesium-lithium-silver alloys were under way in Great Britain. The basic purpose in back of these programs was the development of magnesium alloys that would have better workability than the standard grades. The lithium addition accomplished this by changing the hexagonal close-packed lattice of pure magnesium to a cubic body-centered lattice, which - as predicted - had far better workability. Additions of third elements, such as aluminum, were found to be advantageous in improving mechanical properties. These alloys proved, however, to have a serious deficiency in that the strength decreased rapidly above about 150 C. Also it was found essential to use sodium-free lithium and special low-sodium fluxes. Perhaps these drawbacks explain why magnesium-lithium alloys have as yet not found commercial use. The military has been interested in this development as shown by the 1951 Product Engineering article.

R S Busk, D L Leman and J J Casey: The Properties of Some Magnesium-Lithium Alloys Containing Aluminum and Zinc. TAIME 188 (1950) pp 945/951; disc 191 (1951) pp 556/557

P D Frost, J H Jackson, A C Loonam and C H Lorig: The Effect of Sodium Contamination on Magnesium-Lithium Base Alloys. TAIME 188 (1950) pp 1171/1172; disc 191 (1951) pp 557/558

W Hume-Rothery, G V Raynor and E Butchers: Equilibrium Relations and Some Properties of Magnesium-Lithium and Magnesium-Silver-Lithium Alloys. J Inst Metals 71 (1945) pp 589/601

J H Jackson, P D Frost, A C Loonam, L W Eastwood and C H Lorig: Magnesium-lithium Base Alloys - Preparation, Fabrication, and General Characteristics. TAIME 185 (1949) pp 149/168

P E Landolt: Lithium. Rare Metals Handbook (1954) pp 215/254 Magnesium Confined to Military Applications. Product Engineering 22 (1951) no. 10, pp 140/141

C. As far as the accuracy of the phase diagrams is concerned:

1) Mg-Li. Sager and Nelson in the 1948 Metals Handbook, as well as Jackson, Frost, Loonam, Eastwood and Lorig, and Landolt give about the same diagram, which does not include Shamray's two main changes in the previous diagrams (namely, a new phase at about 98/100 atomic % Li; and the composition of Mg_2Li rather than Li_2Mg_5). The first two of these references include in their bibliographies the 1935 paper of Shamray and Sal'dau, but obviously they do not accept its data at full value.

J H Jackson, P D Frost, A C Loonam, L W Eastwood and C H Lorig: see above reference
P E Landolt: see above reference
G F Sager and B J Nelson: Li-Mg Lithium-Magnesium. Metals Handbook (1948) p 1224

2) Al-Li. There are only relatively minor discrepancies between the diagram given in Metals Handbook and that given by Shamray; but, on the whole, the two main features of Shamray and Sal'dau's diagram have been accepted (as opposed to older diagrams, the compound AlLi, which melts without decomposing; and a eutectic between $AlLi_2$ and lithium).

W L Fink and L A Willey: Al-Li Aluminum-Lithium. Metals Handbook (1948) p 1162

3) Al-Mg. The Metals Handbook diagram and the Kurnakov-Mikheyeva diagram are in approximate agreement at the two ends, but there are some differences in the complex middle section from about 35 to 60 atomic % Mg.

W L Fink and L A Willey: Al-Mg Aluminum-Magnesium. Metals Handbook (1948) p 1163

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4) Al-Mg-Li. Neither the Battelle Memorial Institute nor the Dow Chemical Co paper included complete ternary diagrams. Some of the data on phases present in specific alloys are not in agreement with Shamray's diagrams as to the specific phases present, although they do agree in general as to the number of phases present. Further light on the accuracy of Shamray's ternary diagram could be obtained from a recent Air Force report that is not available here, as it includes isothermal sections at 500 and 700 F.

R S Busk, D L Leman and J J Casey: see above reference
J H Jackson, P D Frost, A C Loonam, L W Eastwood and C H Lorig: see above reference
A Jones, J H Lennon, R R Nash, W H Chang and E G MacPeek: Magnesium Alloy Research Studies. U S Air Force, Air Research and Development Command, Wright-Patterson Air Force Base, Technical Report 52-169 (1952) 125 pp

D. Shamray's claim to be the first to investigate this ternary system appears to be justified. His modesty is rather refreshing when he states that it is quite possible that his diagram may be changed by future work.

E. Only five of the 25 references are Russian. The foreign references appear to be quite complete with the surprising exception of the 1945 paper by Hume-Rothery, Raynor and Butchers. Since Part I was submitted on 13 March 1947, this omission would indicate an appreciable delay in reception of the British publication.

8. Plastic Deformation and the Size of the Unit Lattice Cell by B M Robinskiy and T V Tagunova (?). Zhurnal Tekhnicheskoy Fiziki 17 (1947) no. 10, pp 1137/1142

A. Research. The effect of elastic deformation on lattice dimensions has long been known but there has been some disagreement on the effect of plastic deformation. X-ray diffraction tests were made on filings of "Armco" iron, pure copper, copper-zinc solid solution with 19 at% Zn and copper-aluminum solid solution with 17 at% Al, both after filing and after subsequent stress-relieving treatments up to the recystallization temperature. (As filed and after the lower temperature treatments, the lines were too diffuse to permit calculation of the lattice dimensions.)

1) The size of the unit lattice cell is not changed by plastic deformation.

2) Changes in lattice symmetry as the result of plastic deformation must therefore be considered as independent of an inelastic change in the cell size, although there is probably a relative between this rotation and the preceding distortion of the lattice, which is evidenced by a weakening of the intensity of the X-ray lines.

3) The results also lead to the conclusion that the findings of Wood, and Smith and Wood (references 1, 4, 5, 6) of a permanent change in the size of the unit cell cannot be considered as a permanent inelastic deformation of the lattice. Probably it was only a permanent elastic deformation, which appeared as a result of the plastic deformation of the polycrystalline samples as a whole.

B. In the USA it has long been considered as proved that interatomic spacings are altered by elastic stresses but not by plastic flow. An X-ray diffraction test therefore measures elastic stresses only. This is one of its advantages over other types of strain gages, which are affected by both elastic and plastic strains.

C. Only three of 12 references are Soviet.

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9. Influence of Relaxation and Recrystallization on the Magnetic Properties of Soft Magnetic Materials by V I Drozhzhina, M G Luzhinskaya and Ya S Shur. Zhurnal Tekhnicheskoy Fiziki 18 (1948) no. 2, pp 167/174

A. Practical. Tests were made on transformer sheet (4% Si, balance iron) and "molybdenum permalloy" (4% Mo, 78.5% Ni, 17.5% Fe) to determine the effect of cold working and subsequent annealing on magnetic properties. These tests confirmed the technological instructions published in 1940 (reference 3); namely, for best magnetic properties, soft magnetic alloys must be completely recrystallized by annealing after all fabrication work is finished. The usual way of handling these materials is to recrystallize them at the producing plant after final rolling; then, after fabrication, they are again annealed at the user's plant. This is unsatisfactory because the cold working during fabrication varies from one part of the sheet to another. Therefore the final anneal does not lead to complete recrystallization. The best procedure would be to omit the first anneal. Then the cold work during fabrication would be added to the cold work of rolling, so the single final anneal would give fully recrystallized material with the maximum properties. Commercial tests in 1940 (reference 3) showed the tremendous improvement in magnetic properties of finished electrical equipment that could be so obtained.

B. The instructions issued in 1940 certainly seem to have made little impression on industry in eight years.

C. The deleterious effect of plastic strain on the magnetic properties of soft magnetic materials has long been known. In the case of the silicon transformer sheet, however, high-temperature anneals have an added advantage in that carbon is precipitated in a less harmful form, and, when special atmospheres are used, the carbon content is markedly decreased.

D. It is believed that the major difficulty is probably inadequate annealing at the user's plant. Unless this annealing treatment were improved, it is improbable that the maximum properties would be obtained even if the mill anneal were omitted. Allegheny Ludlum Steel Corp, for instance, has this to say about annealing high-nickel soft-magnetic materials:

> "This entire process of annealing is a delicate operation and one which cannot be handled too well on a production basis without encountering some difficulty. Since Allegheny Ludlum has considerable experience in annealing this material, it is recommended that the customer return laminations and parts for heat treatment. In case where the customer desires to carry out the annealing process, it is suggested that sufficient pieces for test purposes be subjected to standardized annealing treatment to serve as a basis for comparison. These pieces should be sent to Allegheny Ludlum..."

In many cases, the completely fabricated parts (laminations, shields) are purchased directly from the mill. In such instances, the parts are fully annealed after all mechanical operations and are ready for service without further treatment.

Allegheny Ludlum Steel Corp: Allegheny Ludlum Blue Sheet - Allegheny Mumetal EM 12 (1947)

E. Both grades mentioned in this paper are known and used in the USA for similar purposes. The best of the properties given on the "molybdenum permalloy" are comparable to those obtained in the USA.

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10. On the Question of the Interaction of the Forming Die and the Body being Plastically Deformed by I M Pavlov. Izvestiya Akademii Nauk SSSR Otdeleniye Tekhnicheskikh Nauk (1949) no. 1, pp 85/99

A. A rather general, not too mathematical discussion.

1) The cause of the action of the die on the body being deformed and the reaction of the deformed body on the die is not always given sufficient attention.

2) In general there is always a reaction to every force. An elastic spring is a suitable model.

3) In plastic deformation there are, in addition to reverse-action stresses, also irreversible stresses, the cause of which may be the special characteristics of movement and action of the forming die and the friction between the die and the body being deformed.

4) Tearing of the material by the forming die is related to the superficial interaction between them.

5) Asymmetric conditions require particular attention from the standpoint of the effect of external stresses.

6) The number of real combinations of three main stresses and their reaction is 26.

B. Seven references, all in Russian but two are translations from English.

11. Results of the Leningrad Conference on High-Speed Machining of Metals by A P Sokolovskiy and V A Blyumberg. Stanki i Instrument 19 (1948) no. 9, pp 1/12

A. A report on 23 talks given at this conference, which lasted from 11 to 15 May, 1948, and was attended by 1222 persons.

1) High-speed machining is defined as any machining operation using higher speeds than those used before World War II.

2) Examples of high-speed turning and milling are given.

3) Sintered carbides are used for high-speed machining: T15K6U and T15K6S; VK8 and VK6 for cast iron. T30K4 has given very promising results in initial tests. VNII is developing new hard alloys, particularly titanium alloys for machining cast iron, and alloys for machining very hard and chilled cast iron.

4) Relatively limited data indicate that excessively rapid wear is not encountered in high-speed machining.

5) In some cases high-speed machining may be done with existing equipment. Even then, however, high-speed machining makes additional demands in respect to faster set-ups and more efficient chip disposal.

6) The economic consequences of high-speed machining are tremendous. If only high-speed milling were introduced in the entire USSR, at least 700,000,000 rubles a year would be saved. But, of course, the ruble saving does not give the whole picture as the increased productivity would be even more important.

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B. The general approach appears to have been that of the practical machinist, superintendant or engineer. Precise details are given on tools but metallurgical and scientific factors appear to have been ignored. For instance, the microstructure of steels and other alloys was not mentioned (except in the case of an austenitic alloy); although it has been shown in the USA to have a highly significant effect on machinability. Moreover the possible use of free-machining steels seems not to have been discussed. Also, some generalities were so broad as to indicate that the speakers (and authors) had little if any knowledge of materials. An example is one case where machining conditions are given for "soft" steels, then for "quenched" steels with hardnesses up to 60 Rc. There is, of course, a tremendous difference among heat-treated steels, which may have hardnesses from 25 Rc or less to over 60 Rc. At 30 Rc, high-speed steels can easily be used and are; at 60 Rc, mostly grinding and very little machining is done in the USA. Even at intermediate hardnesses (such as 280,000 psi tensile strength), sintered carbides are not sufficiently tough for all types of machining, so high-speed steels must be used.

Increased Production Reduced Costs through a better understanding of the machining process and Control of Materials Tools Machines. Prepared by Curtiss-Wright Corp for Machinability Research Program Sponsored by U S Air Force Resources Planning Section Industrial Planning Division Air Material Command Contract 33 (098)9948, vol 1 (1950) and vol 2 (1951)

F M Rayburn: Machining of High-Tensile Strength Steel. ASME paper no. 53 SA-33 (1953)

Surprisingly enough, another factor that is hardly touched on is cutting fluids. It is not clear whether this means high-speed machining is generally done dry, or whether cutting fluids may be under the jurisdiction of a different group.

C. On the whole, Soviet practice does not seem to be too different from the USA.

1) The cutting speeds are about the same as those used here. The low side of the Soviet range generally agrees with average cutting speeds in the USA; the high side, with speeds used here under favorable conditions. As an example, in one place the Soviets give a cutting speed of 330/985 fpm for turning soft steel with a depth of cut of 0.12/0.24 in. and a feed of 0.012/0.03 in./rev. For "average work" Carboloy gives a cutting speed of 275/475 fpm for cutting the analogous SAE 1010/1025 with a depth of cut of 5/64 to 5/32 in. and a feed of 0.010/0.020 in./rev. This also indicates that the Russian expression "high-speed machining" includes much that would be considered only ordinary machining and not high speed in the USA.

Carboloy Co Inc: Carboloy Tool Catalog GT-250 (1950)

2) Similar negative rake angles on milling cutters have been used in the USA for some time, especially for high-speed milling.

The Cincinnati Milling Machine Co: A Treatise on Milling and Milling Machines (1945)

3) The same arguments about the proper method of holding sintered-carbide inserts (brazing or mechanical) have been going on in the USA too for some time.

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D. Two interesting items:

1) There is no indication of any particular difficulties with highly alloyed materials, such as the high-alloy steels and nonferrous alloys used in the USA for gas turbines. In the USA considerable difficulty has been encountered in production machining of some of these grades.

2) Mention is made of the use in a few plants of electro-erosive methods of grinding sintered carbide tools. (This process was recently discussed in a review of Chudoba.) In this respect, the USSR appears to have been ahead of the USA.

J Chudoba: Electro-Erosive Metal Removal. Schriftenreihe des Verlages Technik vol 94. VEB Verlag Technik Berlin (1953) 107 pp

F J Lennon: Step Up Efficiency in Carbide Grinding. Steel 135 (1954) no. 6, pp 92/93

E. On the other hand, no mention is made of hot machining, which was originally suggested in the USA about 1943; although most papers did not start to appear until considerably later. More recent developments (since this conference), such as carbon-dioxide cooling, were also not discussed.

S Tour and L S Fletcher: Hot Spot Machining At Work Temperatures of 500, 1000 and 1500° F. Iron Age 164 (1949) no. 3, pp 78/89

E T Armstrong, A S Cosler Jr and E F Katz: Machining of Heated Metals. TASME 73 (1951) pp 35/42; disc 42/43

F. The precise compositions of the grades of sintered carbide mentioned are not known. Nor is it clear just what is meant by the "titanium alloys for machining cast iron". In the USA, the titanium-containing grades of sintered carbide have generally been used for steel (where the titanium acts to mitigate cratering) but not for cast iron.

12. Investigation of the Process of Compacting Single-Phase Powder-Metallurgy Substances by V A Ivensen. III - On the Laws Governing the Volume Change of Powder-Metallurgy Substances During Sintering (Answer to M Yu Bal'shin). Zhurnal Tekhnicheskoy Fiziki 18 (1948) no. 10, pp 1290/1305

A. Mathematical and theoretical considerations of various factors governing the relation between decrease in pore volume and initial density. Some experimental data are included. Bal'shin's criticisms in connection with the first two parts of this series are incorrect and unjustified.

B. The experimental results seem reasonable although they are expressed in different units from those generally used here. Procedural details are not clear, but they were perhaps covered in the first two papers.

C. It is difficult to evaluate the validity of Bal'shin's criticisms from a partisan presentation. Bal'shin's main objections appear to have been based on the equations used to represent the compacting and sintering processes. Schwarzkopf, who has analyzed Bal'shin's work, has said:

"Since Balshin does not discuss the role of this liberated energy, and since in general his assumptions seem oversimplified, the practical value of his mathematical formulations is doubtful. However, the experimental results accompanying his theoretical discussions of the compacting process represent a valuable contribution to the phenomenology of the compacting process...

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"The author's concepts regarding the sintering process appear to be based on sounder foundations than is his compacting theory..."

It therefore seems quite possible that Bal'shin's criticisms of Ivensen's papers were not completely justified.

P Schwarzkopf: Powder Metallurgy. New York (1947) pp 276/278

D. None of the materials mentioned or tested is very unusual. Tungsten carbide and titanium carbide would, of course, be of interest in connection with the manufacture of sintered carbides. Cobalt and, perhaps, nickel would probably be involved in connection with their use as bonding media for sintered carbides either for tool and die applications, or for elevated-temperature uses. Iron and copper might have been taken into consideration either for high-density powder-metallurgy parts or for "self-lubricating" parts where the processing is such as to leave a predetermined volume of pores. Ivensen himself gives no indication of any practical uses of these materials.

13. Priority of Russian Scientists in the Field of Mechanics of the Process of Cutting Metals by A I Kashirin and F A Barbashov. Stanki i Instrument 19 (1948) no. 8, pp 1/6

A. Propagandistic mathematics. Merchant's work in the USA and his "new" theory have attracted considerable interest. Many Soviet scientists do not realize that Merchant basically contributed nothing new to the theory first presented by Zvorykin and Briks in Russia over 50 years ago. Merchant has merely made more precise the physical meaning of some constants on the basis of his experiments, but otherwise - except for some errors - he has contributed nothing to the Zvorykin-Briks theory. On the contrary, the latter work was actually incomparably more strict and convincing mathematically. Zvorykin's theory has been compared with Merchant's in reference 7. Therefore the present paper gives a mathematical analysis of Briks' work with references to Merchant's publications.

B. There is no way of knowing how closely Kashirin and Barbashov have followed Briks' original presentation and whether any expedient changes may have been made in the light of Merchant's work.

C. In the USA, Merchant is considered to be one of the outstanding investigators in this field. Apparently there was some agreement with this evaluation in the USSR.

D. Merchant in one of his latest publications does not mention this "earlier" work of Zvorykin and Briks.

M E Merchant. Metal Cutting Research - Theory and Application. Machining - Theory and Practice. ASM (1950) pp 5/44

E. Apparently the Soviets believe in the old proverb about the prophet. Although Zvorykin and Briks have not been honored in the USSR, they evidently should have been in the USA. It is fairly clear that Zvorykin and Briks' work was not generally known in the USSR - Kashirin and Barbashov specifically deplore the fact that the mechanics of cutting has not always been given the necessary attention in the USSR despite its importance - and probably would not have been resuscitated in 1948 if it had not been for the interest aroused by Merchant's excellent work.

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14. For Consolidating the Connection between Technical Sciences and Industry for Strengthening Scientific Help to the Great Stalin Edifice of Communism.
Izvestiya Akademii Nauk SSSR Otdeleniye Tekhnicheskikh Nauk (1951) no. 11, pp 1609/1624

A. Slightly dated propaganda, suitably larded with quotations from L P Beriya and J V Stalin. This editorial is an elaboration of the criticism of the Division of Technical Sciences (OTN) first expressed in Pravda on 17 Sept 1951 and echoed in the Presidium of the Academy of Sciences on 28 Sept 1951.

1) The ivory-tower attitude of workers in the various institutes under OTN endangers further expansion of Soviet industry, which needs the help of the technical sciences.

2) Much of the work carried out in the institutes has no practical significance.

3) Part of the blame for insufficient communication between science and industry is placed on the lack of adequate plant experience on the part of the members of the institutes.

4) Sufficient attention is not being given to recruiting new personnel for the institutes.

5) The necessary reform of OTN can be successfully accomplished only by suitable marxist-leninist education of the scientists. There must be more free criticism, self-criticism and discussion of the work of the institutes.

6) As a glowing example in the true spirit of communist self-criticism, the deficiencies of technical magazines including Izvestiya are discussed.

B. Specific examples of the inadequacies of various institutes and a number of actual production figures are given. Most of these are in terms of increases over the previous year. For example, the increased production of pig iron in 1951 as compared with 1950 was 2,700,000 tons; of steel, about 4,000,000 tons; of rolled products, 3,000,000 tons. Some of these figures must be hopeful approximations, since it would be impossible to know in October (when, presumably, this article was written for the November issue) exactly what the year's production would be.

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